would require each state to reduce SO_2 levels by a specified quantity (as determined by an allocation formula), and would offer no financial relief for doing so (except through existing tax provisions for capital equipment). This approach essentially embodies the "polluter pays" rule, since the polluter would have to assume all the abatement costs. Assuming that the states developed appropriate abatement plans, these options would cost the least, but would also yield the highest drop in expected high-sulfur coal production. A variant of the basic polluter pays approach would mandate the same emission reductions, but would also restrict the amount of low-sulfur coal that could be substituted for high-sulfur coal (the polluter pays with fuel-switching restrictions option). While this approach would raise overall costs by essentially forcing some utilities to install scrubbers, it would also limit projected losses in high-sulfur coal demand.

Other approaches would use economic incentives to discourage coal switching and encourage more scrubber use. One scheme would provide direct grants to those who installed scrubbers, using funds from a tax imposed on fossil-fuel electricity production. Two other alternatives also would subsidize scrubber installation, funding these subsidies by either a tax on SO_2 emissions or a tax on the sulfur content of the coal used. In the latter two policies, the taxes and subsidies themselves would provide financial incentives as the only means to achieve emission reductions.

Comparison of Costs

Two themes emerge from a comparison of the effects of the various options: first, the cost of abating one ton of SO_2 emissions rises as emission reduction targets are increased from 8 million to 12 million tons per year, with costs rising most steeply after 10 million tons; and second, costs rise as efforts are made to protect high-sulfur coal markets through the use of fuel-choice restrictions or subsidy policies designed to encourage scrubber use (see Summary Table 1). Using the polluter pays options as examples, the results show costs would be $270 per ton of SO_2 abated at the 8 million ton rollback level (Option II-1A), rising to $360 per ton at the 10 million ton rollback level (Option II-2A), and reaching $779 per ton at the 12 million ton rollback level (Option VI-3). In fact, the marginal cost of achieving an additional 2 million ton reduction by moving from an 8 million ton to a 10 million ton rollback would be about $720 per ton of SO_2 removed. Further increasing this rollback to 12.1 million tons would cost about $2,775 for each additional ton abated. Costs would rise much more steeply at the stricter levels of SO_2 control because switching to low-sulfur coal--a relatively cost-effective option at moderate reduction levels--would be supplanted by scrubber use as control targets became more ambitious. In effect, scrubber use would become mandated at high levels of emission control.

SUMMARY TABLE 1. CHARACTERISTICS AND EFFECTS OF OPTIONS

Option Characteristics	Polluter Pays Option II-1A	Option II-1B	Option II-2A	Option II-2B
SO_2 Emissions Reduction from 1980 Levels (In millions of tons)	8.0	8.0	10.0	10.0
Scrubber Subsidy Formula or Mandated Coal-Market Restrictions	None	No subsidies; 80% of 1995 coal purchases must be same type as purchased in 1985	None	No subsidies; 80% of 1995 coal purchases must be same type as purchased in 1985
Revenue Mechanism	None	None	None	None
Total Programs Costs (In billions of discounted 1985 dollars) a/	20.4	23.1	34.5	50.8
Cost-Effectiveness (In discounted 1985 dollars per ton of SO_2 reduced) b/	270	306	360	528
1995 Coal Production Changes in Four Key High-Sulfur States (In millions of tons per year) c/	-48.3	-39.0	-74.6	-44.0
1995 Changes in Coal Mining Employment Levels in Four Key High-Sulfur Coal States c/	-14,100	-11,600	-21,900	-12,800

(Continued)

SUMMARY TABLE 1. (Continued)

Option Characteristics	Electricity Generation Tax and Subsidy				
	Option III-1A	Option III-1B	Option III-2A	Option III-2B	Option III-2C
SO_2 Emissions Reduction from 1980 Levels (In millions of tons)	8.0	8.0	10.0	10.0	10; 7 from top 50 emitters, remainders from utilities according to excess emissions formula
Scrubber Subsidy Formula or Mandated Coal Market Restrictions	90% of annual capital cost subsidy	Subsidies for 90% of annual capital cost and 50% of annual O&M costs through 2015	Subsidy for 90% of annual capital cost	Subsidies for 90% of annual capital cost and 50% of annual O&M costs through 2015	Subsidy for 90% of annual capital cost
Revenue Mechanism	0.5 mills/kwh tax on fossil-fuel electricity production	1.0 mills/kwh tax on fossil-fuel electricity production	0.5 mills/kwh tax on fossil-fuel electricity production	1.0 mills/kwh tax on fossil-fuel electricity production	0.75 mills/kwh tax on fossil-fuel electricity production
Total Program Costs (In billions of discounted 1985 dollars) a/	22.3	30.0	35.5	41.5	49.0
Cost-Effectiveness (In discounted 1985 dollars per ton of SO_2 reduced) b/	291	389	369	431	509
1995 Coal Production Changes in Four Key High-Sulfur States (In millions of tons per year) c/	-36.3	-13.6	-53.5	-37.7	-28.6
1995 Changes in Coal Mining Employment Levels in Four Key High-Sulfur Coal States c/	-10,800	-4,500	-12,600	-11,200	-8,900

(Continued)

SUMMARY TABLE 1. (Continued)

Option Characteristics	Emissions Tax and Subsidy: Option IV-1	Emissions Tax and Subsidy: Option IV-2	Emissions Tax and Subsidy: Option IV-3	Sulfur Tax and Subsidy: Option V-1	Sulfur Tax and Subsidy: Option V-2
SO_2 Emissions Reduction from 1980 Levels (In millions of tons)	9.2	9.5	9.6	8.9	8.9
Scrubber Subsidy Formula or Mandated Coal Market Restrictions	None	Subsidy for 90% of annual capital cost	Subsidies for 90% of annual capital cost and 50% of annual O&M costs through 2015	Subsidy for 90% of annual capital cost plus $0.50 rebate per pound of sulfur scrubbed	Subsidies for 90% of annual capital cost plus $0.50 rebate per pound of sulfur scrubbed
Revenue Mechanism	Tax of $600 per ton SO_2 emitted on pre-NSPS sources	Tax of $600 per ton SO_2 emitted on pre-NSPS sources	Tax of $600 per ton SO_2 emitted on pre-NSPS sources	$0.50 per pound of sulfur contained in excess of 10 pounds per ton	$10 per pound of sulfur contained in excess of 0.4 pounds per million Btus
Total Program Costs (In billions of discounted 1985 dollars) a/	37.5	39.2	45.9	32.1	37.4
Cost-Effectiveness (In discounted 1985 dollars per ton of SO_2 reduced) b/	327	330	384	289	339
1995 Coal Production Changes in Four Key High-Sulfur States (In millions of tons per year) c/	-61.0	-43.6	-27.2	-49.7	-44.0
1995 Changes in Coal Mining Employment Levels in Four Key High-Sulfur Coal States c/	-17,900	-12,828	-8,500	-14,600	-12,900

(Continued)

SUMMARY TABLE 1. (Continued)

Option Characteristics	Options Based on Two Recent Congressional Proposals Option VI-1 d/	Option VI-2 e/	Option VI-3 f/
SO_2 Emissions Reduction from 1980 Levels (In millions of tons)	9.1	9.9	12.1
Scrubber Subsidy Formula or Mandated Coal-Market Restrictions	Amount needed to keep electricity price hikes below 10%; fuel-switching and scrubber costs eligible	Amount needed to keep electricity price hikes below 10%; fuel-switching and scrubber costs eligible	None
Revenue Mechanism	0.5 mill per kwh fee on fossil fuel electricity produced; optional	0.5 mill per kwh fee on fossil fuel electricity produced; optional	None
Total Program Costs (In billions of discounted 1985 dollars) a/	25.9	34.9	93.6
Cost-Effectiveness (In discounted 1985 dollars per per ton of SO_2 reduced) b/	299	368	779
1995 Coal Production Changes in Four Key High-Sulfur States (In millions of tons per year) c/	-57.7	-62.0	-45.8
1995 Changes in Coal Mining Employment Levels in Four Key High-Sulfur Coal States c/	-17,000	-18,100	-13,400

SOURCE: Congressional Budget Office.

NOTE: For options that involve taxes, excess revenues generated by the option are not considered part of program costs.

a. Reflects present value of sum of annual utility costs incurred over the 1986-2015 period, using a real discount rate of 3.7 percent.

b. Represents the discounted program costs, divided by the annual discounted SO_2 reduction measured over the 1986-2015 period.

c. Based on changes between option and current policy (base case) in 1995 for Illinois, Indiana, Ohio, and Pennsylvania.

d. Based on H.R. 4567 provision requiring achievement of a statewide emission average of 1.2 pounds SO_2 per million Btus for all affected plants.

e. Based on "default" provision of H.R. 4567, requiring all affected plants within a state to meet a 1.2 pounds SO_2 per million Btus limit.

f. Based on S. 2203, which requires affected plants to meet a 0.7 pound SO_2 per million Btus limit.

Costs would also rise, even at low levels of emission rollbacks, if measures were taken to reduce future losses in high-sulfur coal demand. For example, coal-switching restrictions would raise the cost per ton abated (cost-effectiveness) from \$270 (Option II-1A) to \$306 for the 8 million ton rollback case (Option II-1B). Fuel choice restrictions would cost much more in the 10 million ton rollback case, raising costs from \$360 (Option II-2A) to \$528 per ton of SO_2 abated (Option II-2B), making this approach the most expensive in the 10 million ton reduction range. Simply mandating scrubber use would be nearly as expensive, however. Option III-2C would require scrubbers on 50 of the highest emitting power plants as part of a 10 million ton reduction, and would cost \$509 per ton of SO_2 abated.

Scrubber subsidies, designed to promote scrubber installation and thus discourage fuel switching, also would increase costs. Capital and operation and maintenance (O&M) subsidies provided through an electricity tax would raise the per ton abatement cost of an 8 million ton reduction to \$389 (Option III-1B), and that of a 10 million ton reduction to \$431 (Option III-2B). The cost-effectiveness values of scrubber subsidy programs would improve, however, when considered in conjunction with SO_2 taxes on emissions or the sulfur content of coal, since these mechanisms would encourage greater emission reductions in addition to influencing the choice of abatement method. For about the same cost per ton reduced, Option IV-3 (employing an SO_2 tax with scrubber subsidies) could reduce SO_2 emissions by 1.6 million tons more than Option III-1B, which also uses subsidies but does not tax emissions. The same trend is also seen with the sulfur-in-fuel tax options that would provide scrubber subsidies.

Summary Table 1 also reports total discounted program costs as measured over the 1986-2015 period. Because this value is an estimate of the cost of a policy over a fixed time period, policies that achieve abatement earlier than others would tend to have higher program costs even if the ultimate abatement levels were comparable. Thus, total program costs would be higher for all the options that tax SO_2 emissions or the sulfur content of coal. This effect would occur because such taxes would be imposed immediately, thus encouraging utilities to reduce SO_2 sooner than would other rollback options, which would cost utilities nothing if they delayed abatement until the required compliance deadline (1995). In this respect, the cost-effectiveness figures--which represent a discounted sum of costs incurred divided by the emission reductions obtained over the period--show less variation caused by the timing of abatement.

Coal-Market Effects

The high-sulfur coal industry is especially prominent in the states of Illinois, Indiana, Ohio, and Pennsylvania. Under current policy, total coal production in these four states is expected to remain virtually constant for the next decade. Enacting SO_2 regulations to control acid rain, however, could lower both coal production and mining employment in these states by 1995.

With no restrictions on the fuel market, an 8 million ton SO_2 reduction (Option II-1A) could lower projected 1995 coal production in the selected states by 48 million tons or 24 percent; similarly, a 10 million ton reduction (Option II-2A) could lead to a 75 million ton decrease, or a 38 percent drop (see Summary Table 1). To alter this trend, it would be necessary to restrict fuel switching outright, require scrubbing, or change the economics of scrubber use to make it more attractive than fuel switching.

With restricted fuel switching, mining production losses in the four key states would range from 39 million tons with an 8 million ton rollback (Option II-1B) to 44 million tons with a 10 million ton rollback (Option II-2B). The respective cost-effectiveness values, however, would jump from $270 to $306 per ton of SO_2 abated under the 8 million ton case, and from $360 to $528 under the 10 million ton case. Alternatively, subsidies from an electricity tax could be used to finance scrubbing, thus making it less expensive to the utilities compared with fuel switching. For a 10 million ton reduction, subsidies on scrubber capital and O&M costs could lower mining losses (in the four selected states) to only 38 million tons (Option III-2B). Mandating that scrubbers be used on the highest emitting power plants (Option III-2C) could further reduce mining losses to just 29 million tons, but with a large increase--to $509 per ton--in the cost of reducing SO_2.

Alternatively, emission or sulfur taxes could be used in combination with scrubber subsidies to maintain high-sulfur coal production, while keeping the cost per ton of SO_2 reduced to a level below those of options that restrict fuel choice or mandate scrubbers. For example, a 9.6 million ton SO_2 reduction could be achieved through a tax of $600 per ton on SO_2 emissions, combined with a subsidy on scrubber capital and O&M costs (Option IV-3). Enacting this option would lower 1995 mining production in the selected states by only 27 million tons, at a cost of $384 per ton of SO_2 abated.

Finally, as the level of control is tightened to a 12 million ton reduction, coal production in these four states could actually fare better than under an unrestricted 10 million ton rollback, because the stringent level of control demanded would essentially force a high degree of scrubber installation even in the absence of subsidies. Thus, under Option VI-3, 1995 coal production would only be 46 million tons less than in the base case. Requiring such stringent emission limits, however, would be exceedingly costly at $779 per ton of SO_2 reduced.

Mining employment in the high-sulfur coal industry also would be affected by these production shifts. For the states of Ohio, Illinois, Indiana, and Pennsylvania, direct mining jobs are expected to remain near the current level of 56,000 under current policy. As expected, the larger the expected production drop in this four-state area, the larger the expected drop in 1995 mining jobs. Thus, Option II-2A, which could lower coal production by 75 million tons from 1995 base case levels, also could eliminate about 21,900 job slots. But if expected job attrition is considered, only 15,300 miners employed in 1985 in these four states would actually lose their jobs by 1995 as a result of the effects of Option II-2A.

These results lead to a straightforward conclusion about SO_2 control programs of 8 million tons or more: policies that mitigate expected losses in high-sulfur coal production and mining jobs increase the cost of reducing SO_2 emissions. These results are illustrated graphically in Summary Figures 1 and 2 which show, respectively, the cost to abate one ton of SO_2 and 1995 mining employment in the four prominent high-sulfur coal states under each option. As job levels rise, so do costs. Some of the options that tax emissions or sulfur content, however, could potentially save the most jobs at the least cost.

Finally, on a nationwide basis, the coal production and employment losses of the different options tend to be negligible. The potential drop in production and employment in the Midwest and Pennsylvania would be offset by increased production and employment in western states, southern West Virginia, and eastern Kentucky--all sites of abundant quantities of low-sulfur coal.

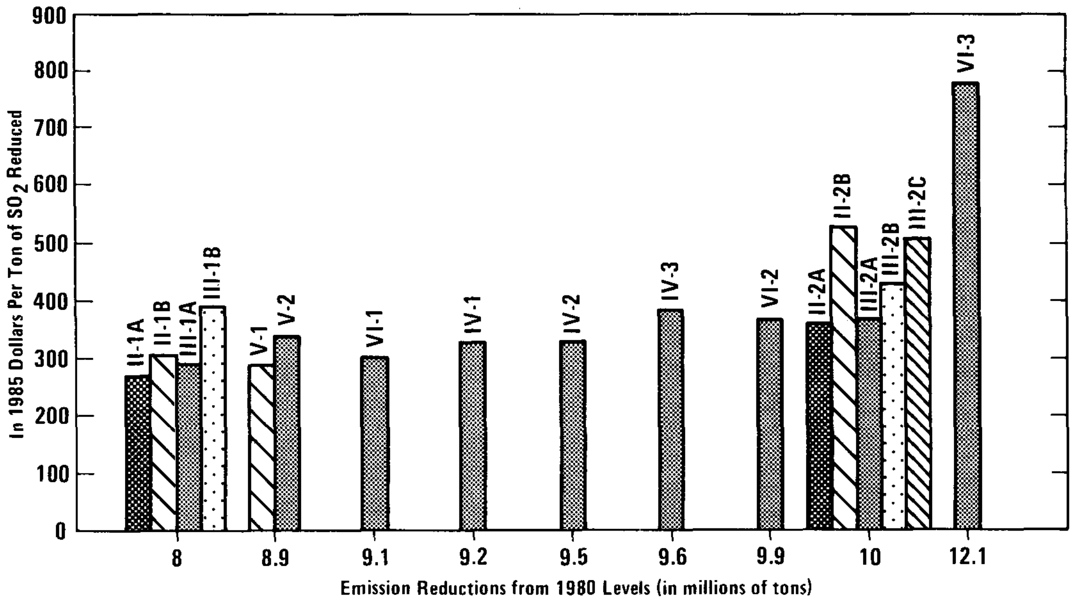
Effect on Electricity Rates

Under any option examined, average electricity rates throughout the country would not rise more than 6 percent over those predicted under current policy, using 1995 as the year of comparison (typically the year when such prices could be highest under any control program). Rate increases in some states could be much higher, however, depending on the option. The highest rate increases are concentrated primarily in the midwestern and Appalachian states because a significant share of emission reductions would occur in those regions. These states have enjoyed some of the lowest rates charged nationwide, though, and the higher prices these areas might experience under an acid rain control plan would still be below the national average price predicted under most options.

Other states, such as West Virginia, might experience wide fluctuations in rates, depending on how much of their electricity is imported or exported.

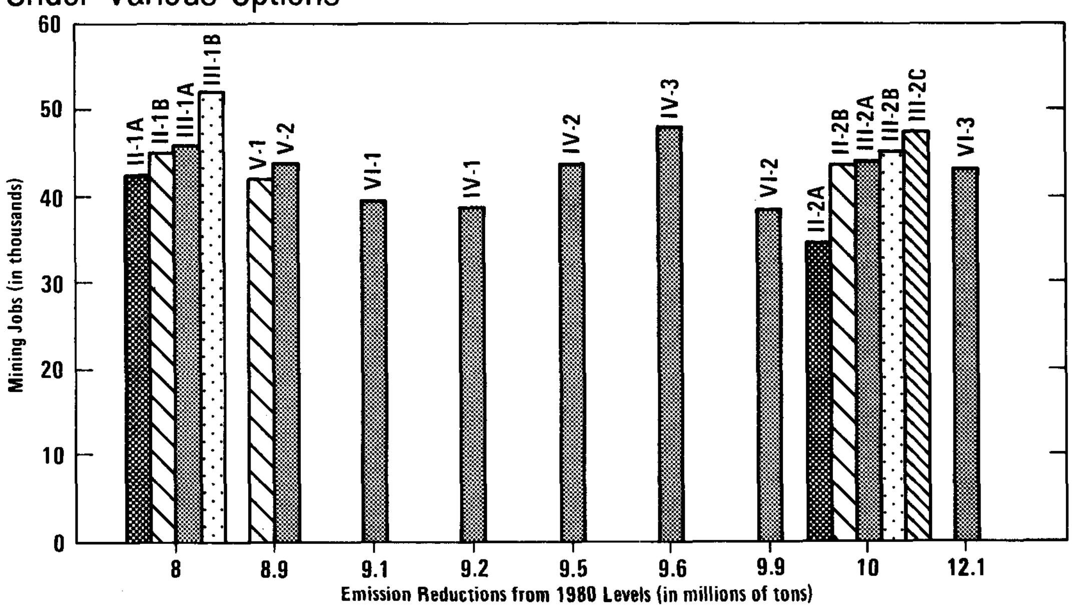
Summary Figure 1.

Cost-Effectiveness of Various Options



Summary Figure 2.

Mining Jobs in Ohio, Illinois, Indiana, and Pennsylvania in 1995, Under Various Options



(Theoretically, if one state can export excess power to another state at the receiving state's higher cost, consumer costs in the exporting state could fall.) Because of the myriad of electricity rate regulations affecting such interstate transfers, however, such results are open to question.

The Potential Budgetary Effect of Various Tax Schemes

Each of the tax options could potentially raise large amounts of revenue in excess of the cost of the subsidies (if any) that would be granted under the particular program. The smallest surpluses would be generated by the electricity tax and subsidy alternatives. Of these, the largest cash excess would be created by Option III-1A, which would raise about $1.2 billion each year from an electricity tax of 0.5 mills per killowatt-hour over a ten-year period, while paying out subsidies of roughly $239 million each year over roughly a 20-year period. Because revenues would be deposited in a trust fund, interest earnings could produce a closing balance of $15.7 billion in 2015, the year it would expire.

The largest revenue-raising alternative would be Option IV-1--the $600 per ton emissions tax with no subsidy program. This option would collect $4.9 billion annually by 1995, even after some emission reductions occurred. This value would slowly decline as older, taxed power plants were retired, probably by 2015.

The use of excess cash balances created by such programs is open to debate. 2/ In several bills submitted in the 98th Congress, the consensus approach was to refund excess taxes to those who paid them (for example, electricity ratepayers who were subject to an electricity fee). Large excess cash balances, however, might allow some or all of the funds to be used for deficit-reduction activities. Such activities might include using the funds to pay for other environmental programs, thus offsetting funding from general revenues, or simply retaining the funds to offset total federal outlays.

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2. Unless specific exclusions were included, the various tax and subsidy options using trust funds would become subject to the Balanced Budget and Emergency Deficit Control Act of 1985 (P.L. 99-177) if they were enacted into law. Under the Balanced Budget Act, outlays (subsidies) from the trust funds would be subject to sequestration action through fiscal year 1991, although revenues accruing to the fund probably would not be affected. If trust fund outlays were sequestered, or cut, the trust fund balances would continue to grow and would be available for future obligations. Because future sequestration needs cannot now be determined, estimates in this report assume outlays would provide full subsidies, as long as trust fund balances were positive.

CONCLUSIONS

Summary Figures 1 and 2 summarize the dilemma created by schemes to lower SO_2 emissions nationwide--namely, the expense of reducing emissions tends to increase as efforts are made to preserve jobs in the high-sulfur coal industry. Simply restricting fuel choice by requiring that current purchase patterns be maintained appears to be the most expensive approach, both in terms of cost-effectiveness and total costs. Demand for high-sulfur coal could be preserved and cost-effectiveness improved by using economic incentives that tax emissions or sulfur content to help fund scrubber installation. But total costs for these programs could be high because the continuing expense of reducing emissions is incurred earlier than in other programs. In contrast, the least expensive approach--and the least protective for high-sulfur coal demand--would simply mandate emission reduction targets for each state to meet by 1995, placing no restrictions on fuel switching and providing no economic incentives to use scrubbing in place of lower-sulfur coal.

CHAPTER I

INTRODUCTION

Along with hazardous waste disposal, "acid rain" has entered the public spotlight as a key environmental concern of the 1980s. Airborne acidic compounds, which are formed chiefly from man-made air pollution, can harm aquatic ecosystems, crops, materials, forests, and even human health after long exposure. Moreover, contributing sources can produce both local and remote damage, since the acidic substances can travel hundreds of miles in the atmosphere.

The pollutant most often singled out as the principal "precursor" of acid rain is sulfur dioxide (SO_2). It is called a precursor chemical because it can be transformed in the atmosphere to sulfate, the compound that is believed to contribute directly to the total acidity entering ecosystems. U.S. electric utilities produce large quantities of sulfur dioxide (over 17 million tons in 1980, or 65 percent of the man-made total). Coal-fired power plants, most of which are located in the Midwest and parts of the mid-Atlantic region, are almost exclusively responsible for this pollution from utilities.[1] Those plants burning high-sulfur coal contribute an especially large proportion of the total SO_2 produced by utilities.

Even though other air pollutants have been implicated in the formation of acid rain--most notably nitrogen oxides (also produced from fuel combustion) and photochemical smog (itself a product of hydrocarbon and nitrogen oxide pollution from automobiles and industry)--legislative proposals to mitigate the effects of acid rain have focussed on controlling SO_2 emissions. The sources most often targeted for control are older, coal-fired electricity plants that account for over 90 percent of national utility SO_2 emissions. However, the cost of controlling emissions from these plants is high, the results of curbing them unknown, and the potential effects on domestic coal markets and electricity costs sufficiently large to warrant Congressional scrutiny. These issues form the subject matter of this paper.

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1. See Environmental Protection Agency, *National Air Pollutant Emission Estimates, 1940-1980* (January 1982).

THE NATURE OF THE PROBLEM

Acid rain threatens the viability of many thousands of lakes and streams in the eastern United States and Canada, and may have contributed to the destruction of forests and the consequent decline of timber production in these regions. Moreover, airborne fine particles, of which acid rain is a component, have been linked to increased human mortality in areas with elevated pollution levels. Yet, the relationship between SO_2 emissions in a particular location (for example, the Midwest) and the downwind damage of acid rain (in the eastern United States and Canada, for instance) remains elusive to many researchers. While some urge immediate further controls for plants that emit SO_2, others stress that the problem and its corrections need additional research before further actions are undertaken (see box).

THE REAGAN-MULRONEY AGREEMENT

Currently, no regulatory programs exist specifically for controlling acid rain in the United States, although substantial research efforts --with both private and public funding--are devoted to understanding the problem and the means to control it. While some members and committees of the Congress have introduced legislation designed to control pollutants that form acid rain (no legislation has reached the floor of either House in the 99th Congress), the Administration has not taken part in initiating any regulatory action. In 1985, however, President Reagan and Prime Minister Mulroney of Canada commissioned a special study of the acid rain problem. Among the conclusions of the report, delivered on January 8, 1986, was the finding that acid rain was a serious environmental problem that warranted an increased research effort devoted to devising methods to control the sources of pollution.

In a joint statement with Mr. Mulroney on March 19, 1986, President Reagan endorsed the findings of the report and made a commitment to pursue actively the implementation of its recommendations, including: initiation of a $5.5 billion, multi-year program for the commercial demonstration of cost-effective and innovative pollution control technologies for major sources of acid-forming pollutants; continued emphasis on research to help answer critical scientific questions related to transboundary acid rain; and enhanced cooperation between the United States and Canada, such as regular bilateral consultations and information exchanges. While the President did not suggest any regulatory action, he plans to seek funding as needed to meet the recommendations of the report. (For further information, see Environmental Protection Agency, Office of Program Development, "Official Response to the Joint Envoys Report," March 19, 1986.)

This study does not examine the scientific issues concerning the origin, effects, and fate of acid rain pollution. Research in these areas has been described thoroughly in other publications. 2/ Instead, this paper focuses on the difficult policy choices surrounding the further control of SO_2 emissions from the nation's power plants.

UTILITY REGULATION AND DOMESTIC COAL MARKETS

To understand the public policy issues impinging on proposals to control acid rain, it is helpful to understand the relationship between SO_2 control and coal use. Because coal with a high sulfur content releases a large volume of SO_2 when burned, its producers fear that additional reductions in allowable SO_2 emissions could lower the demand for high-sulfur coal and increase the use of low-sulfur coal. The major midwestern coal-producing states of Indiana, Illinois, and Ohio, plus Pennsylvania, would be most affected by such a substitution. These states produce an abundant quantity of high-sulfur coal and employ thousands of miners. Displacing high-sulfur coal with low-sulfur coal, however, would benefit the western states and West Virginia. These regions contain large quantities of low-sulfur coal and would be able to produce and sell more of it, as well as enjoy higher employment under a plan to control acid rain.

Under the provisions of the original Clean Air Act of 1970, coal-fired power plants had to meet individual sulfur dioxide emission limits, measured as pounds of SO_2 per million British Thermal Units (Btus) of fuel used. For plants built before 1971, states were allowed to determine the allowed emission limit; for plants built later, the federal government had established a uniform standard that applied nationwide. In establishing these standards, the federal government and most states allowed utilities to choose either to burn low-sulfur coal to keep SO_2 emissions down, or to use high-sulfur coal and remove SO_2 in the exhaust gas with scrubbers. 3/ When allowed a choice, utilities generally complied by using low-sulfur coal.

2. Many publications are available on the scientific issues underlying the acid rain problem. These include two recent documents, one published by the Congressional Office of Technology Assessment, *Acid Rain and Transported Air Pollutants: Implications for Public Policy*, June, 1984; and the other published by the National Academy of Sciences, *Acid Deposition: Atmospheric Processes in Eastern North America* (1983). The reader is urged to consult these and other studies for more details.

3. A scrubber is a large and expensive piece of equipment that removes sulfur dioxide from combustion gasses before they are emitted from the stack. Most are designed to remove about 90 percent of the potential sulfur dioxide emissions produced during combustion, and can cost as much as $120 million when placed on a medium-size (500 megawatt) new power plant. A scrubber placed on an older power plant usually costs more, however, if it is not part of the original design. This expense would confront many of the power plants that would be targeted under an acid rain control program.

Since the sulfur content of domestic coal resources varies geographically, significant changes in nationwide SO_2 emission regulations could influence the regional distribution of coal production. The East mines both low- and high-sulfur coal and can supply either to utilities. Eastern low-sulfur coal is very high quality and could be burned without scrubbers and still meet strict SO_2 emission standards, but this region's high-sulfur coal would need scrubbers when burned under the same conditions. The Midwest mines essentially only high-sulfur coal, and power plants under strict SO_2 emission limits typically would have to use scrubbers to burn midwestern coal. The West, on the other hand, can produce and ship as much low-sulfur coal as needed.

Partly to counter a potential reliance on low-sulfur coal as a control strategy, the 1977 Amendments to the Clean Air Act changed the nature of SO_2 emission standards for new plants by essentially requiring scrubbing for all new plants regardless of the type of coal used. (The term "new power plant," as used here, refers to facilities built after the emission regulations that arose from the amendments passed by the Environmental Protection Agency in 1978.) Before that law was enacted, utilities had often turned toward low-sulfur coal to meet SO_2 standards. The 1977 amendments (and subsequent 1978 emission standards established specifically for power plants) eliminated the advantage of using low-sulfur coal to meet SO_2 emission limits in new plants. Only the newest plants are subject to the stricter requirements, however, and older plants remain covered by typically less strict federal or state regulations. In the Midwest, these state standards often are written to allow high-sulfur coal to be burned in older power plants that are remotely located and that use tall stacks to disperse the pollution. Because of the more lenient standards for old plants--and the elimination of low-sulfur coal use as a sole SO_2 compliance strategy in new plants--midwestern coal production is expected to remain strong for many years under current clean air rules.

THE POTENTIAL EFFECTS OF ACID RAIN LEGISLATION

Acid rain proposals directed at reducing utility SO_2 emissions raise two principal concerns: possible regional shifts in the coal market and the cost of further controlling SO_2. Most proposals have considered reducing U.S. sulfur dioxide emissions by between 8 million tons and 10 million tons per year (measured from 1980 levels). Power plant SO_2 emissions in the continental United States are now about 16 million tons per year, and are expected to rise to 18.5 million tons annually by 1995. The Congressional Budget Office projects that a one-time only reduction in sulfur dioxide emissions of 8 million tons, directed at power plants built before 1980 (and paid for entirely by the affected utilities), would add between $1.9 billion and $2.1 billion each year to the cost of current regulations; a 10 million ton reduction program would add between $3.3 billion and $4.7 billion each year.[4] These costs depend greatly on whether the new legislation would permit switching from high- to low-sulfur coal to meet emission standards--which would alter existing coal-market patterns--or whether scrubbers would be required--which would help mitigate the advantage of using low-sulfur coal to meet standards. Unrestricted coal markets that permit fuel switching generally lower costs, while the required use of scrubbers generally raises costs.

Many diverse interests would be affected by a new SO_2 control program directed at electric utilities. From the utilities' perspective, most would prefer the freedom to choose a compliance method--either low-sulfur coal or scrubbers, whichever would cost less. Because utility costs ultimately are passed through to consumers, electricity customers also would prefer the cheapest method of compliance. From the perspective of coal producers, preferences are influenced by geography. Western and eastern producers of low-sulfur coal hope that fuel switching would be allowed under an acid rain control program. In contrast, midwestern and some eastern high-sulfur coal producers favor the required use of scrubbers. Finally, geography also differentiates between, for example, states thought to benefit from a control program and those believed to bear its costs; the Midwest and some mid-Atlantic states would face the greatest cleanup costs, while the Northeast might enjoy the greatest potential benefits from a reduction in acid rain.

In an attempt to satisfy this diverse set of concerns, the Congress has been exploring proposals that alter the basic "polluter pays" principle. This principle requires that sources responsible for pollution--in this case, the coal-fired electric utilities--pay for the cost of cleanup. Adhering to this rule could require two areas of the country--namely, the Midwest and mid-Atlantic--to pay a large share of the cleanup costs of an acid rain control program. Thus, schemes have been proposed that would distribute more evenly the costs of cleanup throughout the nation, as well as lower the potential nationwide redistribution of coal production that might result from new SO_2 regulations. This paper analyzes these options, concentrating on how much various control programs would cost, who would bear these costs, how the programs would affect coal markets and mining jobs, how much

4. Power plants operating by 1980 in almost all cases were started before the 1978 regulations, and were thus not subject to the newer standard that requires all new plants to install scrubbers regardless of the type of coal burned.

emissions would be lowered, and how the programs could be financed and administered. Four approaches are examined:

- The traditional **polluter pays approach** that requires utilities and their consumers to pay for sulfur dioxide controls without placing restrictions on the use of control method; and a similar control program, but one that would deny utilities the choice to change to a low-sulfur coal as a control strategy;

- A control program that places no formal restrictions on choice of control technology, and that **partially finances scrubber installation with an electricity tax**;

- An option that **taxes sulfur dioxide emissions** to motivate utilities to adopt control measures, and that provides partial subsidies to the utilities for installing scrubbers; and

- An alternative that **taxes the sulfur content of fuel** and that provides subsidies for scrubber installation to motivate emissions reduction.

Through the use of subsidies, some of the approaches would alter the basic polluter pays principle by transferring costs from those who pollute the most to those who pollute the least. All would do so in an attempt to strike a balance among competing goals: achieving emission reductions, alleviating the costs to consumers and utilities in any one region, and minimizing disruptions to coal market patterns and employment in the high-sulfur coal industry.

CHAPTER II

CURRENT POLICY AND THE POTENTIAL COSTS OF FURTHER REDUCTIONS IN SO_2 EMISSIONS

From 1985 through 1995, the electric utility industry is expected to spend about $190 billion on new capital equipment; of this amount as much as 20 percent will pay for devices to control air pollution. The use of coal also is expected to grow over this period--from 883 million tons shipped in 1985 to 1,129 million tons shipped in 1995. This growth will be spurred mostly by new coal-fired power plants built to meet increasing demand for electricity. Concurrent with growing demand for electricity, annual sulfur dioxide emissions from utilities will rise from 15.8 million tons in 1985 to almost 18.5 million tons in 1995.

What would be the cost of imposing new regulations designed to increase control of sulfur dioxide emissions? To answer this question, this study examines federal options that would lower SO_2 emissions from electric utility plants by 8 million tons or 10 million tons annually (measured from the commonly used baseline level of 1980). As a starting point, this chapter reports the cost of such regulations, assuming that abatement expenses are borne directly by the affected utilities, without benefit of any cost-sharing program or taxation-subsidy scheme. Later chapters present various cost-allocation and taxation-subsidy programs to control acid rain, describing how they might affect utilities, electricity consumers, and coal markets.

The results of the Congressional Budget Office's (CBO) analysis suggest that a SO_2 control program to abate acid rain would be expensive and would affect U.S. coal-market patterns. An SO_2 reduction of 8 million tons (from 1980 levels) could add between $1.9 billion to $2.1 billion to annual electricity production costs by 1995; similarly, a rollback of 10 million tons could raise 1995 electricity costs by $3.2 billion to $4.7 billion. In addition, such regulations could alter future patterns of coal production in specific regions. Predicted demand for midwestern high-sulfur coal would fall, while predicted demand for low-sulfur coal from eastern (Appalachian) and western mining regions would grow. To retard the substitution of low-sulfur coal for high-sulfur coal under a SO_2 rollback, fuel switching could be restricted directly (by regulation) or indirectly (by requiring that SO_2 emission scrubbers be used by all power plants regardless of the kind of coal burned). Limiting fuel choice, however, would force overall costs to the higher end of the ranges cited.

REQUIREMENTS OF THE CLEAN AIR ACT CURRENTLY AFFECTING ELECTRIC UTILITIES

To help meet and maintain national ambient (atmospheric) air quality standards established under the Clean Air Act (last amended substantially in 1977), several key regulations have been developed to control emissions from sources of air pollution. 1/ Electric utility plants represent a large category of such sources. Power plants built before 1971 (predating the promulgation of the first federal emission limits for utilities) must meet emission standards set by the states through "state implementation plans" (SIPs). These standards vary by state and by regions within a state, depending on local air quality. Their primary purpose is to ensure that plant emissions do not prevent achievement or maintenance of ambient air quality standards established by the Environmental Protection Agency (EPA).

For plants built after 1971, the federal government has established uniform emission standards--called new source performance standards (NSPS)--that limit the amount of air pollution from new or modified facilities. 2/ Two NSPS have been developed for utility plants--one in 1971 and one in 1979 (see Table 1). The important difference between the two standards is that the 1971 NSPS allowed low-sulfur coal to be used as a pollution control strategy, while the 1978 one does not. The 1978 standard essentially requires the use of scrubbers--no matter what type of coal is burned--by mandating a percentage reduction of all SO_2 emissions.

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1. This chapter is not intended to provide a thorough description of current air pollution control policy. For a complete description of the Clean Air Act and the effect of its regulations, see National Commission on Air Quality, *To Breath Clean Air*, Final Report to Congress (March 1981).

2. For new plants, the NSPS typically represent the norm for emissions control. The states and federal government generally do not require stricter standards except in certain situations, which usually can be avoided through careful siting of the facility to minimize its pollution effect. Nevertheless, certain situations may call for controls stricter than the federal NSPS. For example, in areas where the ambient air quality standards are already exceeded, states may set stricter emission limits for a new facility (subject to federal approval) if such limits are needed to attain standards. Alternately, in areas where air quality is very good, new plants may be given stricter standards if pollution from the plant at NSPS levels would degrade the air quality beyond permissable amounts. (The regulations outlining this strategy are called Prevention of Significant Deterioration, and are described in *To Breathe Clean Air*.) Finally, simply at their own discretion, states may enact standards stricter than the federal NSPS, a practice that has occurred only infrequently and mostly in the West.